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COMBAT DATA BASE DEVELOPMENT: LESSONS LEARNED

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This paper describes the lessons learned from several research and development efforts to develop a combat data base, an automated analysis and retrieval system, and data normalization techniques for analysis. These lessons were learned from several efforts and contracts to develop the data base.

Technically, combat data bases need to be collected systematically. The data collection techniques include: (a) identify the required data, (b) identify the data available, (c) identify any data shortfalls, (d) structure the data collection forms prior to data collection, (e) define the data collection procedures, (f) identify the data collection skills required, and (g) train the data collectors. Also, before the data can be analyzed, they should be normalized to match the conditions and characteristics of the desired scenario of the analysis effort. Finally, in using foreign data, key characteristics of the data should be reviewed and compensated for, because the foreign data are inherently different from ours.

Additional lessons were learned concerning contract management. Specifically, the contract monitor should aggressively review and address contract management issues. These issues include reviewing and identifying inconsistencies between contractor progress and cost reports, financial records, and delivery schedules. (KR)

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SUMMARY

Successful wartime demand rate forecasting depends heavily on historical data from which to project those demands. Historically, peacetime data are used to make these projections. Previous analysis suggests that continued use of this approach may provide misleading conclusions.

For several years the Air Force Human Resources Laboratory has investigated the problem of using actual combat data in this analysis. This paper addresses some of the lessons learned from this investigation. Both technical and contract management issues are discussed. Technical areas include how the data should be collected, normalizing the data for analysis, and specific concerns with using combat data. Even though the procurement process is well defined, several actions are recommended to assist the contract manager in the administration of a contract.

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PREFACE

This paper summarizes some of the lessons learned over the past 5 years while developing a combat data base from actual combat operations. These lessons were learned from various contracts and efforts conducted by the Air Force Human Resources Laboratory (AFHRL). These research and development efforts were part of an overall Logistics and Human Factors Division (AFHRL/LR) approach to forecast wartime demand rates using combat data instead of peacetime data. The final product is also usable by analysts in the operations, maintenance, and combat modeling arenas.

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I. INTRODUCTION

There is a need for the United States Air Force (USAF) to develop an analytical basis for forecasting requirements necessary to maintain adequate sorties during wartime conditions. Successful and efficient sortie generation depends heavily on data: operations, intelligence, threat, logistics and maintenance data. Peacetime data are readily available, but complete and accurate data for wartime operations are rarely available. The underlying problem of meeting this need is obtaining accurate and valid data in a usable form to conduct analysis. This research effort was directed at resolving these problems.

The objectives of this research and development (R&D) effort were: (a) the collection of integrated aircraft maintenance, logistics, threat, and operations data from an actual conventional war with opposing Soviet built aircraft; (b) the collection of identical data from a peacetime environment for comparison; (c) the development of an automated data retrieval and analysis system to manipulate the data; (d) the development of normalization techniques to relate the data to present US aircraft; and (e) the analysis of the data base to identify anomilies.

Since the USAF has not been involved in a sustained conflict since the Vietnam War, the required data was only available from a foreign source. This greatly complicated the contracting process. The contract strategy used was a classified sole source contract with a US company. However, the majority of the work was subcontracted to a foreign company with the required expertise and the necessary clearances.

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This paper will address some of the lessons learned from this effort including several related contracting issues. Development of a combat data base which integrates various data areas is extremely difficult. Even though the contracting process is well defined, the contract monitor's responsibilities for contract management includes many time-consuming administration tasks.

II. TECHNICAL ISSUES

Data Collection Techniques

Combat data collection should not be limited to quickly getting the desired data for a specific use. Combat data collection is an expensive process and must be approached systematically so that the data can have multiple uses. The following data collection techniques should be followed during actual combat situations, major exercises, operational readiness inspections (ORI), or drills.

1. <u>Identify required data</u>: Extensive effort must be taken to identify not only the immediate data requirements from planned data collection activities but also future requirements. Once the data collection activity is completed, it is too late to add data requirements. Also, if possible, consider the data requirements of other likely user organizations. This increases the useability of the data base.

2. <u>Identify available data</u>: All available sources of the required data must be reviewed. During any data collection activity, the validity and accuracy of each data element identified must be examined. This examinination should include when the data were collected, where they were collected, how they were recorded, and who recorded them. For example, during exercises, data can be collected

by an assessor or technican participating in the exercise or by independent data collectors. Personnel participating in the exercise are normally in an ideal position to provide the most accurate data. However, the pressures of the situation, such as time, mission oriented protective posture (MOPP) gear, and evaluations, can distort the reliability of such data. Hence, the useability of data collected from existing data reporting forms must be reviewed. Independent data collectors record data from their obsevations. They should not interfere with the exercise. If they do not see it, they can not record it. The pros and cons of each approach must be examined for each data element.

3. <u>Identify data shortfalls</u>: When all the required data are already being accurately collected, the missing data (data shortfalls) must be addressed. If the data shortfalls can not be added to the data collection effort, other techniques, such as comparability analysis or computer simulation, should be used. Data with questionable reliability or validity puts the resuts of any analysis in question.

4. <u>Structure the data collection forms</u>: Prior to the data collection, the data collection forms need to be structured to allow for the easy recording of the data. Easy to use forms allow the data collector to concentrate on the accuracy of the data instead of the recording of it.

5. <u>Define data collection procedures</u>: The procedures that the data collectors must follow should be defined in enough detail to cover expected situations. These procedures should then be tested in a simulated environment and refined if necessary. The more situations that are covered the more reliable the data collection process.

6. <u>Identify the data collection skills required</u>: The kind of data being collected should help determine the necessary skills of the data collectors. For example, damage repair data should be collected by a maintenance technican not a logistics specialist or computer analyst. Understanding the job is important part of accurate data collection.

7. <u>Train data collectors</u>: The data collectors should be trained on how to use the data collection forms or data entry devices. The ease of data entry increases the accuracy of data recording.

Normalizing the Data

Normalization of data changes the data from one condition to another desired condition. There are various ways to normalize data. Many analysts attempt to either use the original data directly or modify the original data to the desired condition. Either works well when situations are similar. However, data should not be normalized simultaneously over several conditions, such as from an older aircraft in a surge war to a current aircraft in a sustained war. When the desired condition is not closely related to the original condition, the validity of the data normalized becomes questionable.

To normalize multiple conditions, a logical stepwise procedure must be used. Using the same conditions mentioned above, the first step would be to normalize the data from an older aircraft in a surge war scenario to the same older aircraft in a sustained war scenario. The next step would be converting the normalized parameters from the new conditions (older aircraft in a sustained war) to the current aircraft in the sustained war (old to new aircraft). Step-by-step normalization decreases the probability of errors in the conversion. The same approach can be used to normalize data from other scenarios such as from the Pacific to a European environment.

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Data Base Considerations

Care must be exercised when using data from a foreign source, because it will have different characteristics than our domestic data. The key factors to consider are: (a) the types and lengths of the missions flown; (b) the physical environment, terrain, and weather; (c) the theater of operation; (d) the use of combat tactics such as strafing, pop-up, or loft; (e) the logistics pipelines; (f) the maintenance practices and tools; and (g) the manpower strengths, including the reserves and industrial base.

A simple review will determine if differences are relevant. However, if a significant difference does exist, common comparability analysis is usually the simplest and most accurate method of resolving the differences.

III. CONTRACT MANAGEMENT ISSUES

Because of inconsistencies with the contractor progress reports and performance and cost reports, several lessons were re-learned about the management of the contract that may apply to all R&D contracts, and particularly those with US prime and foreign subcontractors. The contract monitor must continually monitor all reports, deliverables, and tests for compliance with the Statement of Work (SOW).

First, the contract monitor must compare the progress reports, cost reports, and schedule and milestones with each other. Careful attention should be given to relating the technical progress with the schedule to ensure that the contractor is on schedule. The slightest delay may indicate the beginning of technical problems or the late delivery of the Contract Data Requirements List (CDRL) items. Also,

the technical progress should be compared to the performance and cost report to determine if the manpower expended is appropriate. If more manpower has been charged to the effort than seems appropriate, the manpower categories should be thoroughly examined. The contractor could be using less experienced personnel than proposed. The continued use of less experienced personnel may extend the time necessary to complete the contract or may result in an inferior product. Furthermore, the contractor may be expending more manpower than necessary, because the technical effort is more difficult than expected. This could lead to an unexpected cost overrun if not watched closely. Other issues also need to be reviewed. For example, travel should be reviewed to determine if it is appropriate, required by the contract, and scheduled in advance. All costs reported should be continually compared to the technical progress and schedule. Social and cultural differences with foreign companies makes this checking process very difficult.

The contract monitor should periodically participate in an examination of all charges to the contract at the contractor's facility. The contract monitor should be personally involved in this financial review, because there are many charges that can only be identified by a technical person with an understanding of the contract requirements. Actual charges may include specific labor hours for each individual charging to the contract, equipment charged to the contract, computer hours used by type of computer, and consultant and subcontractor charges. The contractor is not required to show the actual records to the contract monitor. However, the contract monitor can request through the Contracting Officer that the Defense Contract Audit Agency (DCAA) office examine the contractor's actual charges on the contract with the contract monitor. Periodic review of the actual charges on the contract for their relevancy reduces the possibility of mischarges to the effort and a cost overrun.

Finally, the contract monitor should closely follow the delivery schedule to ensure that all CDRL items are delivered on time. This includes periodic reports such as the technical progress reports and the cost and performance reports. Continual late delivery of periodic reports indicates a problem and should be reported to the Contracting Officer. Late delivery of the drafts and initial deliveries of major CDRL items must also be reported to the Contacting Officer. Ignoring the contracted delivery schedule can result in the loss of some government rights to the deliverables and authority under the contract to take action.